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Perioperative Stroke Prevention during Carotid Endarterectomy: An Anesthesiologist's Perspective

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CEA: Risks, Co-morbidities, Management

Risk Factors for Stroke during CEA

1. Symptomatic patient with transient ischemic attack (TIA) or stroke
2. Contralateral stenosis present.
3. CEA within 48 hours of TIA or mini stroke
4. Uncontrolled hypertension
5. Hyperglycemia and poorly-controlled diabetes mellitus

Common Co-morbidities in CEA Patients

- ✓ Peripheral vascular disease
- ✓ Coronary artery disease
- ✓ Smoking and COPD
- ✓ Hypertension
- ✓ DM2
- ✓ Obesity

SPECIAL SITUATIONS

CABG

CEA can be done prior to CABG as a staged procedure or as a combined procedure (CEA followed by CABG). There is no difference in stroke rate between these two methods.[1,2]

Clipping of Ipsilateral intracranial aneurysm

When clipping is done first, temporary clipping can lead to cerebral ischemia in already compromised ipsilateral cerebral circulation. When CEA is done in a patient with an unsecured aneurysm, the increased blood flow after unclamping can result in rupture of the aneurysm. It is preferable to do CEA first followed by clipping in another setting. It is important to control the blood pressure (BP) during unclamping and in the postoperative period to prevent increased blood flow through the aneurysm.[3,4]

General (GA) vs. Regional Anesthesia (RA)

Combined superficial and deep cervical plexus block is the most commonly used RA technique. Neurological assessment can be done for perioperative stroke throughout the CEA when the procedure is performed under RA. But the benefit of RA in terms of neurological outcome is not proven. [5, 6, 7]

$PaCO_2$ Management

The ipsilateral cerebral vessels are maximally vasodilated and not responsive to the changes in PaCO2, so hypercarbia diverts the blood flow to contralateral normal cerebral vessels. Hypocarbia increases the blood flow to the ipsilateral areas by diverting the blood to normal vasculature of the contralateral cerebral hemisphere. However the benefit of induced hypocarbia is not proven, thus the current practice is to maintain normocarbia during CEA procedures.

Critical Periods of Anesthesia during CEA

1. Induction of GA	4. Carotid clamping
2. Endotracheal intubation	5. Carotid unclamping
3. Surgical incision	6. Extubation & emergence from GA

Clamping and Unclamping

- Due to carotid artery stenosis, ipsilateral cerebral blood flow is reduced and clamping results in a further reduction. The blood flow to the ipsilateral area is dependent on collateral flow from the contralateral cerebral vessels through the circle of Willis. Therefore, BP should be kept within the normal range during clamping.
- Unclamping can increase the blood flow through the dilated ipsilateral cerebral vessels. This can lead to cerebral hyperperfusion with adverse neurological outcomes. Thus, hypertension should be avoided during unclamping and in the postoperative period.

Shunting

- Provides blood flow from proximal to distal areas of the carotid cross clamp
- Routine shunting: No neuromonitoring required
- Selective shunting: Done when ischemia is identified via a neuromonitoring technique

Shunting increases the blood flow and prevents cerebral ischemia. Insertion of a shunt can lead to embolic stroke.

Monitoring during CEA

1.Routine basic monitoring	2.Invasive arterial monitoring	3.Neuromonitoring techniques

Neuromonitoring techniques[8]

Technique	Limitations
Carotid artery stump pressure	One-time monitor, not continuous during CEA
EEG	Monitors mainly cortical areas, not the white matter
Somatosensory-evoked potential	Monitors the sensory cortex of anterior circulation; other areas are not monitored
Transcranial Doppler (TCD)	Monitors the embolic load during CEA but is operator-dependent
Cerebral oximetry	Monitoring limited to smaller superficial areas of the cerebral cortex

Per a Cochrane database systematic review,[9] no single neuromonitoring technique has proved to be the "gold standard". The monitors (with the exception of TCD) monitor hypoperfusion, but embolism is the most common cause of perioperative stroke.

Post-operative complications of CEA

- ❑ Bleeding, neck hematoma and airway compromise
- ❑ Cerebral hyperperfusion syndrome with neurological compromise

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CONCLUSION:

Perioperative management for stroke reduction includes identifying risk factors and managing hemodynamics optimally during critical periods of anesthesia and surgery, as discussed above. The benefits of selective shunting based on neuromonitoring technique has been proven, but there is no advantage in any one neuromonitoring technique over another.